

**Columbia River Treaty 2014/2024 Review
Sovereign Technical Team Water Quality Working Group**

**October 24, 2011
U.S. Geological Survey
2130 SW 5th Avenue
Portland, OR 97201
(Willamette Conference Room)**

October 24, 2011

9:00 am – 4:30 pm STT-Water Quality Working Group Meeting

Chair: Matt Rea, U.S. Army Corps of Engineers, Treaty Review Program Manager

Working Group Purpose:

Provide a panel of regional experts that will support the Columbia River Treaty 2014/2024 Sovereign Technical Team in developing and implementing a plan for evaluating the water quality impacts associated with Treaty alternatives.

Workshop Summary

1. Introductions, Workgroup Overview and Objectives (10 minutes) *See Attachment One Agenda*

The Sovereign Technical Team (STT) sponsored a public meeting of the Water Quality Work Group on Monday, October 24, 2011. The meeting was led by Matt Rea, U.S. Army Corps of Engineers (Corps), and Greg Fuhrer, U.S. Geological Survey and facilitated by Integrated Water Solutions, LLC. The Water Quality Work Group was formed as a result of the public Water Quality Topical Workshop held in August 2011.

2. Overview of Treaty and Timelines (5 minutes) *See Attachment Two: Treaty Timeline, See Attachment Three: Alternative Characterization and Iterative Approach*

Matt Rea, Corps, lead a discussion of an overview of the Columbia River Treaty 2014/2024 Review, Treaty Review Timeline and Alternative Characterization. Iteration One Alternatives, detailing reference cases for the Treaty Review, were discussed in detail. Water Quality experts were asked to consider models available that take little effort to run in Iteration One that would give useful information moving forward to future studies.

3. Overview of the Expectations Work Sheet (20 minutes) *See Attachment Four: Water Quality Work Group Draft Work Plan*

The STT prepared a draft Water Quality Work Group Work Plan detailing the work group purpose, objectives, sideboards, members, expectations, and possible reference material. This document will be edited to reflect comments of this meeting.

4. Setting the Foundation: what are the alternatives we want to model?

There is an expectation that Water Quality will be assessed qualitatively in Iteration One with more thorough impact assessment in future iterations of study. Iteration Two and Iteration Three seek to refine the studies to inform the Treaty Recommendation. This process is not seeking to optimize the system. Studies done seek to inform the Treaty

recommendation of whether it is in the best interest of the United States to continue, terminate or amend the existing Columbia River Treaty. Further studies may continue post-recommendation to develop system operations as a result of the Treaty decision.

5. Summary of Products from August 31, 2011 Water Quality Work Shop (10 minutes)
See Attachment Five: Water Quality Metrics, See Attachment Six: Iteration one Metrics, See Attachment Seven: Water Quality Prioritization of Metrics and Locations

Matt Rea, Corps and Greg Fuhrer, USGS, gave a recap of products from the August 31, 2011. See Attachments five through seven for products. The products aided in the refinement of Water Quality Metrics and priority locations to characterize. Metrics for Iteration one Primary Operating Purposes of Hydropower, Flood Risk and Ecosystem-based Function were also shared.

6. Break-out Groups

Participants self-selected topical groups to break into: temperature and Total Dissolved Gas modeling; Sediment modeling; and Contaminants Modeling. Groups discussed their relevant water quality parameters, metrics, locations, model(s) available, preferred model, model inputs (data needed), and model outputs. The smaller break out groups then reported their findings back to the larger group. Group leaders were asked to compile notes and outcomes and relay them to the Sovereign Technical Team.

7. Reconvene in Willamette Conference Room; Wrap Up (60 minutes)

The STT Water Quality Work Group identified key action items including: identifying the amount of Water Quality information needed to aid in a Treaty Recommendation; Identifying Water Quality hinge points that would affect a Treaty Recommendation; and identifying a next meeting date.

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9:00 am – 4:30 pm STT-Water Quality Working Group Meeting

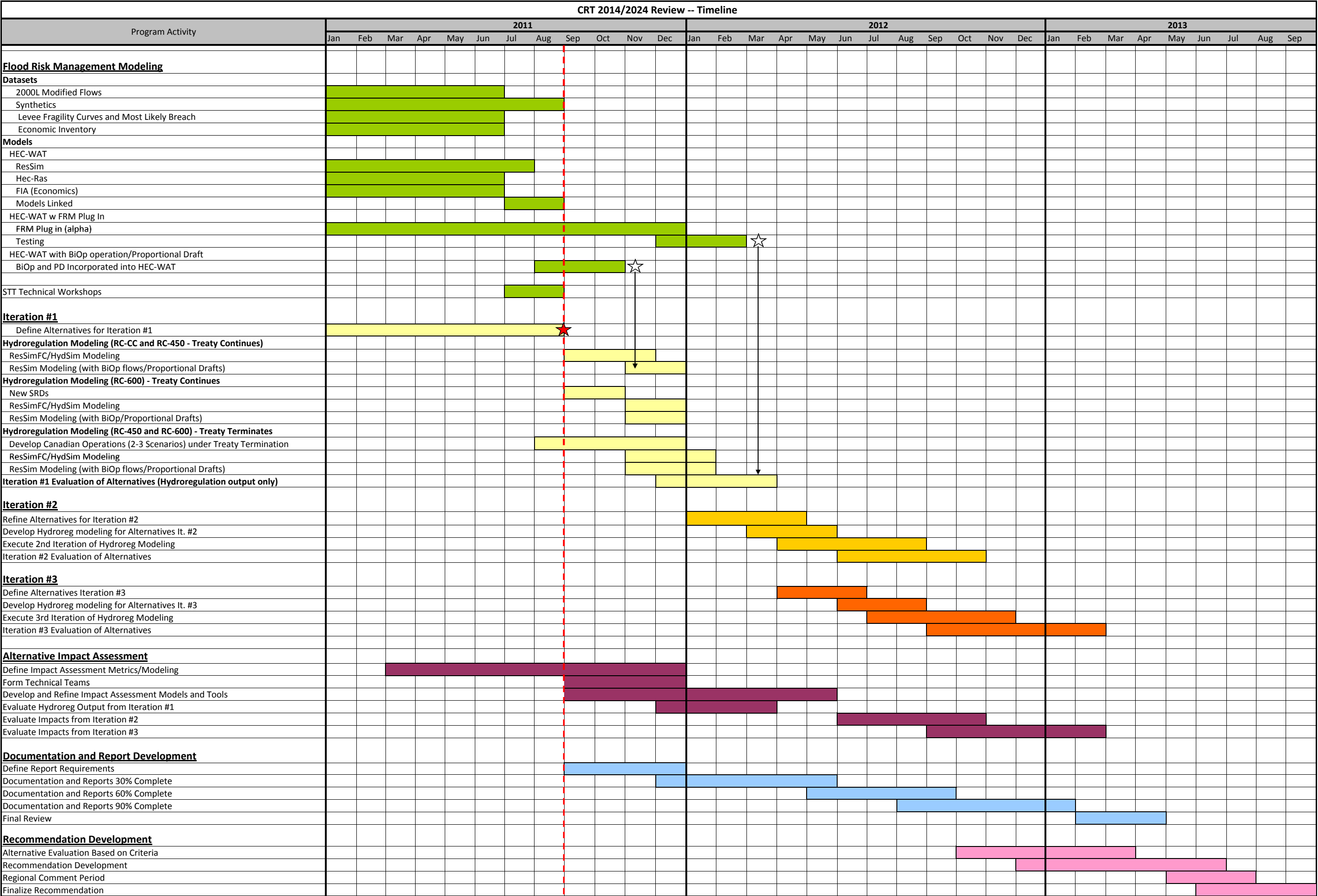
Chair: Matt Rea, U.S. Army Corps of Engineers, Treaty Review Program Manager

Working Group Purpose:

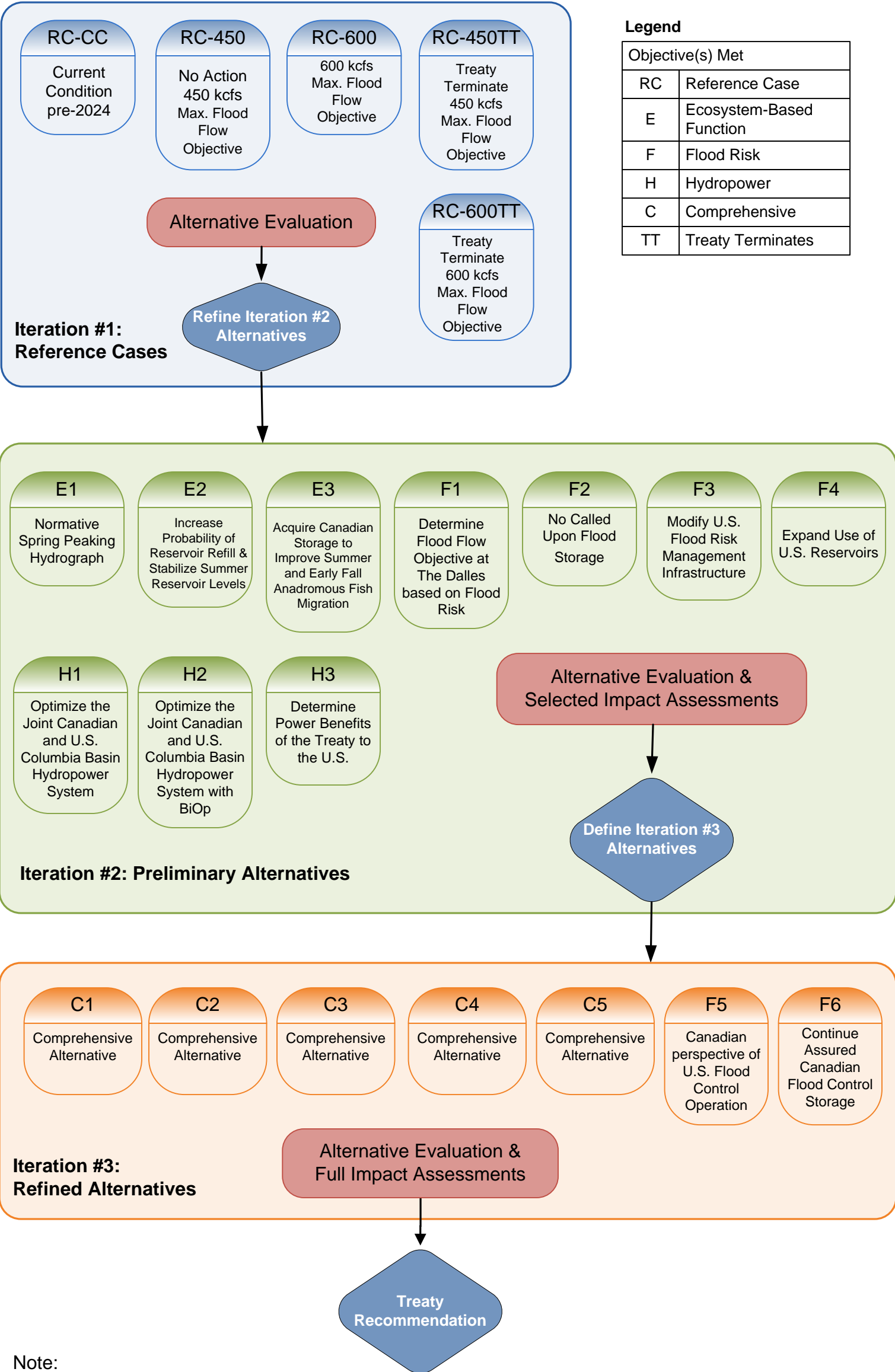
Provide a panel of regional experts that will support the Columbia River Treaty 2014/2024 Sovereign Technical Team in developing and implementing a plan for evaluating the water quality impacts associated with Treaty alternatives.

AGENDA

- 1. Introductions, Workgroup Overview and Objectives (10 minutes)**
- 2. Overview of Treaty and Timelines (5 minutes)**
- 3. Overview of the Expectations Work Sheet (20 minutes)**
- 4. Setting the Foundation: what are the alternatives we want to model?**
 - a. Review Iteration No. 1 Reference Case Alternatives (40 minutes)**
 - b. Review Iteration No. 2 Alternatives for Selected Impact Assessments (10-minutes)**
 - c. Review Iteration No. 3 Alternatives for Full Impact Assessments (5-minutes)**
- 5. Summary of Products from August 31, 2011 Water Quality Work Shop (10 minutes)**
- 6. Break (15 minutes)**
- 7. Break-out Groups (4.75 hours; lunch on your own and PM break included)**
(Identify key parameters to model, reaches or locations, timelines, metrics; data needs)
 - a. Temperature and TDG Modeling (Lead English; STT Rea & notes)**
 - b. Sediment Modeling (Lead-Nilsen; STT-Fuhrer & notes)**
 - c. Contaminants Modeling (Lead-Lyndal Johnson; STT Kim Johnson & notes)**
 - d. Path Forward, Action Items, and Wrap-Up**
- 8. Reconvene in Willamette Conference Room; Wrap Up (60 minutes)**



Columbia River Treaty 2014/2024 Review
Alternative Formulation and Evaluation - Modeling Iterations



Note:
Integration of Climate Change
information to be determined

Columbia River Treaty 2014/2024 Review: Preliminary Alternatives (September 1, 2011)

Alternative Naming Convention Key: *Example: Alternative E2*

Objective(s) Met		No.
RC	Reference Case	#
E	Ecosystem-Based Function	#
F	Flood Risk Management	#
H	Hydropower	#
C	Comprehensive	#

RC-CC: Current Condition through 2024

Alternative Description: Operation of the Columbia River System continues to 2024 following current operating protocols and procedures under the Treaty.

Alternative Features: Current configuration of the Columbia River System with no major changes in levees, dams, and reservoirs from the current system. Current 2011 system operation.

Treaty Nexus: Treaty exists without opportunity to terminate by either Nation prior to 2024

RC-450 & RC-450TT: No Action/Called Upon Alternative (Treaty Continues and Treaty Terminates)

Alternative Description: Post-2024 scenario if neither nation takes action to terminate the Treaty.

Alternative Features: This is the No Action alternative post-2024 with implementation of Called Upon Flood Control operations. Alternative will be run for both Treaty Continues and Treaty Terminates (2-3 scenarios for Canadian operation).

Treaty Nexus: Reference cases for post-2024 operation.

Columbia River Treaty 2014/2024 Review: Preliminary Alternatives (September 1, 2011)

RC-600 & RC-600TT: 600 KCFS Maximum Flood Flow Objective at The Dalles ((Treaty Continues and Treaty Terminates)

Alternative Description:

Change maximum flood flow objective from 450 kcfs to 600 kcfs at The Dalles to evaluate river and reservoir conditions for native resident and anadromous fish and other reservoir uses.

Alternative Features:

Effective use of U.S. Reservoirs authorized for system flood control and Canadian “Called Upon” storage would be used to operate to a maximum flood flow objective of 600 kcfs at The Dalles. Refill is a primary objective of this alternative. Would require new Storage Reservation Diagrams (SRDs) for U.S. reservoirs. Alternative will be run for both Treaty Continues and Treaty Terminates (2-3 scenarios for Canadian operation).

Treaty Nexus:

Would require a revised flood control operating plan that changes the maximum flood flow objective at The Dalles to 600 kcfs. Additionally, this will assist in evaluating the Canadian perspectives concerning the post-2024 flood flow objectives.

Alternative E1: Normative Spring Peaking Hydrograph

Alternative Description:

Increase spring instream flows by forcing a spring peak at The Dalles, creating a more normative spring hydrograph to evaluate river and reservoir conditions for native resident and anadromous fish and other reservoir uses.

Alternative Features:

Based on the forecasted inflows, additional water from U.S. and Canadian reservoirs would be used to force a spring peak flow at The Dalles, mimicking the normative hydrograph. Spill is increased and refill is not a primary objective.

Treaty Nexus:

Treaty is amended because additional water would be required from Canada for this operation.

Alternative E2: Increase Probability of Reservoir Refill and Stabilize Summer Reservoir Levels

Alternative Description:

Draft reservoirs proportional to site-specific inflow forecasts to evaluate refill probability, maintain normative flows in rivers below reservoirs and stabilize reservoir levels July – September in order to improve fish productivity in the headwater reservoirs and river reaches.

Alternative Features:

Minimize reservoir drawdown at U.S. Reservoirs, improve reservoir refill probability and adjust refill date based on water supply forecast. Create gradual flow reduction after the spring freshet.

Treaty Nexus:

Treaty is amended because additional storage and/or coordination would be required from Canada for this operation.

Columbia River Treaty 2014/2024 Review: Preliminary Alternatives (September 1, 2011)

Alternative E3: Assess the Use of Canadian Storage to Improve Summer & Early Fall Anadromous Fish Migration

- Alternative Description:** Assess the use of additional Canadian storage to supply summer and early fall flows to improve anadromous fish migration (2-3 maf?).
- Alternative Features:** Use additional storage from Canada to improve flows in July, August, and early September to benefit anadromous fish.
- Treaty Nexus:** Requires additional Canadian storage for flow augmentation.

Alternative F1: Determine Flood Flow Objective at The Dalles based on Flood Risk

- Alternative Description:** Determine a new flood flow objective at The Dalles based on the assessment of flood risk within the system. Based on information provided on flood risk from reference operations and 600 kcfs maximum flood flow objective (EF1) model runs, select a flood flow objective at The Dalles.
- Alternative Features:** This alternative will use information about flood characteristics derived from running the Reference Operation and alternative EF1, with 450 and 600 kcfs flood flow objectives, respectively, to potentially define a new flood flow objective that provides an acceptable level of flood risk. This alternative will follow the methodologies for called upon use of Canadian storage and effective use of U.S. reservoirs as defined in the reference operation (effective use procedures applied to only 8 U.S. reservoirs with authorized system flood control storage; (Grand Coulee, Libby, Hungry Horse, Kerr, Albeni Falls, Dworshak, Brownlee and John Day). New SRDs for U.S. reservoirs will be required.
- Treaty Nexus:** This alternative will allow us to test whether or not “acceptable” flood risk can be achieved with a different Treaty flood flow objective post 2024 and to determine the potential impacts and benefits on reservoir storage and flow. It will test the assumption that current system operations are a conservative approach to flood risk management.

Columbia River Treaty 2014/2024 Review: Preliminary Alternatives (September 1, 2011)

Alternative F2: No Called Upon Flood Storage

**Alternative
Description:**

This alternative will not use Called Upon flood storage in Canadian Reservoirs. The U.S. would rely on Effective Use of U.S. System Flood Control Reservoirs and Canadian Power drafts to assess flood risk within the U.S.

**Alternative
Features:**

This alternative will use the new flood flow objective defined in Alternative F1 and will follow the methodologies for called upon use of Canadian storage and effective use of U.S. reservoirs as defined in the reference operation (effective use procedures applied to only 8 U.S. reservoirs with authorized system flood control storage; (Grand Coulee, Libby, Hungry Horse, Kerr, Albeni Falls, Dworshak, Brownlee and John Day). This analysis will incorporate Canadian Power Drafts but will not Call Upon additional Canadian storage even if needed to manage for U.S. flood risk objectives.

Treaty Nexus:

Running an alternative without Called Upon Canadian storage will aid in determining the value of Canadian Called Upon storage to managing downstream U.S. flood risk.

Alternative F3: Modify U.S. Flood Risk Management Infrastructure

**Alternative
Description:**

This alternative will modify U.S. flood risk management infrastructure in lieu of requesting Called Upon flood storage from Canada. Infrastructure modifications could include changes to levee systems, flood walls, etc.

**Alternative
Features:**

This alternative would be run with a changed system configuration including modifications to some of the 160 levee systems (based on results from the analysis of flood characteristics shown in alternatives EF1 and F1). Canadian reservoir operations would include power drafts but no Called Upon Flood Control storage. Effective use of U.S. reservoirs would be limited to the 8 reservoirs authorized for system flood control.

Treaty Nexus:

This alternative will allow the U.S. to determine the potential of implementing infrastructure changes as opposed to requesting called upon flood storage from Canada or changing the definition of effective use of related US reservoirs to manage flood risk. Running the alternative without Called Upon Canadian storage will aid in determining the relative costs and benefits/impacts of infrastructure modifications in the U.S. compared to Canadian Called Upon storage.

Columbia River Treaty 2014/2024 Review: Preliminary Alternatives (September 1, 2011)

Alternative F4: Expand Use of U.S. Reservoirs

Alternative Description: Provide an acceptable level of flood risk by expanding the definition of effective use of related U.S. reservoirs without requesting called upon flood storage from Canada.

Alternative Features: This alternative will use the new flood flow objective defined in Alternative F1. Effective Use methodologies and procedures would be expanded to encompass additional U.S. storage beyond the 8 existing projects currently authorized to provide system flood control. Rather than focusing on possible storage in existing reservoirs not authorized for system flood control, “synthetic” reservoirs will be modeled in tributary subbasins to determine the potential effectiveness of additional storage in those basins for reducing downstream flood peaks. Canadian reservoir operations would include power drafts but no Called Upon flood storage.

Treaty Nexus: This alternative will allow the U.S. to determine the potential for using other U.S. storage as an alternative to Called Upon use of Canadian Reservoirs to manage flood risk. Running the alternative without Called Upon Canadian storage will aid in determining the relative costs and benefits of utilizing additional storage in the U.S. compared to Canadian Called Upon storage.

Alternative H1: Optimize the Joint Canadian and U.S. Columbia Basin Hydropower System

Alternative Description: Optimize the joint Canadian and U.S. Columbia Basin hydropower system for power generation and revenues.

Alternative Features: Canadian and U.S. reservoir operations would be jointly optimized for power generation. Biological operational objectives¹ would not be included in the optimization, but would be evaluated in terms of impact assessment. The optimization would maintain local and system flood risk management objectives.

Treaty Nexus: Evaluate whether an optimized joint Canadian and U.S. operation can produce added power benefits to both countries.

¹ As described in the Phase 1 Supplemental Report, Appendix A

Columbia River Treaty 2014/2024 Review: Preliminary Alternatives (September 1, 2011)

Alternative H2: Optimize the Joint Canadian and U.S. Columbia Basin Hydropower System and the Biological Operating Requirements ¹

Alternative Description:	Optimize the joint Canadian and U.S. Columbia Basin hydropower system, with biological operating objectives ¹ included, for power generation and revenues.
Alternative Features:	Canadian and U.S. reservoir operations, including biological operating objectives ¹ , would be jointly optimized for power generation. The optimization would maintain local and system flood risk management objectives.
Treaty Nexus:	Evaluate integrating the biological operating objectives ¹ into Treaty planning and operations.

Alternative H3: Determine Power Benefits of the Treaty to the U.S.

Alternative Description:	Compares the coordinated Treaty operation with the U.S. operations without the Treaty to determine the true power benefits of the Treaty to the U.S. Results will be used to assess whether Canadian Entitlement accurately reflects one-half the power value of the Treaty to the United States.
Alternative Features:	This alternative is a comparison between two scenarios. The first scenario models the Treaty operation with the full U.S. system with implementation of the Appendix A biological objectives. This scenario will likely be the No Action/Called Upon Alternative with the Treaty listed under the references cases. For comparison, a second scenario will look at the full U.S. system operation without the Treaty. This scenario would consist of using the full U.S. system with implementation of the biological operating objectives ¹ , but under several Canadian operations. This scenario would likely be the No Action/Called Upon Alternative with no coordinated Canadian operation (No Treaty). These two scenarios would then be compared against each other and also against the actual calculated Canadian Entitlement for 2024.
Treaty Nexus:	Determines the U.S. power benefits from Treaty coordination.

STT Work Group—Draft Work Plan

Water Quality	
Work Group Purpose and objectives:	<p>Purpose: Provide a panel of regional experts that will support the Columbia River Treaty 2014/ 2024 Sovereign Technical Team in developing and implementing a plan for evaluating the water quality impacts associated with Treaty Review alternatives.</p> <p>Objectives:</p> <ol style="list-style-type: none"> 1. By October 2011, recommend to STT the key Water Quality metrics and priority locations to be used to evaluate Treaty alternatives and provide an outline of an analytical framework to be used to conduct the analysis (including recommended modeling approach). 2. By December 2011 provide a detailed plan and scope of work for developing and implementing the detailed Water quality analytical approach. 3. By March 2012, assist the STT in qualitatively evaluating Water Quality impacts of the first iteration of alternatives and informing the development of the second iteration of alternatives. 4. By November 2012, use models and other analytical tools to evaluate the Water Quality benefits and impacts of the 2nd iteration of alternatives. 5. By March 2013, use models and other analytical tools to evaluate the Water Quality benefits and impacts of the 3rd iteration of alternatives. 6. By April 2013, prepare a final Water Quality report to be appended the Main Report documenting the analytical approaches uses and summarizing the key findings and conclusions regarding water quality impacts
Work Group Sideboards	<p>The Water Quality Work Group will scope and conduct its efforts with consideration of the Treaty Review Study Sideboards established by the SRT. Paraphrased specific to Water quality considerations, they include:</p> <ol style="list-style-type: none"> 1. The Water Quality work group is a sub-element of the STT and coordinates upward through the STT. 2. The geographic scope of water quality analysis is on the Mainstem Columbia River and tributaries affected by possible changes in reservoir operations resulting from future Treaty alternatives. Other reservoirs or rivers in the basin could be considered if they have the potential to ameliorate or exacerbate water quality conditions associated with those alternatives. 3. Hydropower, Flood Control and Ecosystem Function are the three

	<p>primary drivers for formulation of alternatives; it may be critically important for water quality analysis to integrate with the ecosystem function evaluations and with climate change considerations.</p> <p>4. SRT and STT will primarily be responsible for formulating a limited number of alternatives in several iterations; the water quality work group will provide input into water quality considerations that may be incorporated into alternatives as they are refined in later iterations.</p> <p>5. Water quality analysis is intended for understanding implications of future Treaty alternatives on key water quality parameters—not on regulatory compliance or optimizing real time operations or modifying statutory requirements for water quality.</p> <p>6. The key water quality parameters identified for consideration in the CRT 2014/2024 Review alternatives evaluation are Temperature, Total Dissolved Gas and toxic sediments.</p> <p>7. The work group will focus on use of existing models and data; only develop new water quality models or data where it is critical and can be accomplished within the limited timeframe of the CRT Review.</p> <p>8. The work group will produce estimates of the impacts of the alternatives on the key water quality parameters for the reference condition(s) compared against the alternatives.</p> <p>9. There is an expectation that the work group will conduct a quantitative analysis of water quality impacts associated with the alternatives where possible; where not possible due to time, data and or other constraints the work group will assess possible impacts qualitatively.</p> <p>10. Full quantitative and qualitative evaluation of the water quality impacts of alternatives will need to be completed for the alternatives in Iteration 3 by roughly June-October 2012.</p> <p>11. The time and resource requirements for the work group are not clearly defined at this time (we kind of know what needs to be done but we are not clear about what it will take to get it done). There is an expectation that the larger group will meet periodically to craft the scope of work, review interim products and assist in compilation of final documentation. A smaller subset of the larger group, including possibly contracted consultants, will need to be committed to the actual work production.</p>

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Sovereign Technical Team
Working Group Summary

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?	Spokane Tribes		

Expectation	Associated Work Product(s)	Date Required:
Recommend key water quality parameters, metrics and locations to be used to evaluate Treaty alternatives. Recommend water quality models and data to be used in evaluation. Complete the prioritization Table initially developed in the August WQ workshop.	Water Quality Evaluation Plan	Mid-October (can we do this as an outcome of the first Team meeting?)

Develop and describe a modeling framework plan in more detail: What models will be used at which locations for which parameters? How will the models be consolidated and run together. How will we deal with standard model “quality”? How will we deal with boundary conditions? What are the model limitations and constraints? integrate climate change into alternatives; integrate contaminants into alternatives, identify how model outputs will be linked to ecosystem function where applicable. Define scope, schedule and cost.	Modeling Framework Plan	Mid-December
Develop an approach to using hydroregulation model outputs to perform preliminary evaluation of iteration 1 alternatives. Could include running Iteration 1 alternatives through RMB 10	Inform prioritization of iteration no. 2 alternatives	Jan-May 2012
Assist in straw dog development of comprehensive alternatives in iteration no. 3.	Probably, much the same as listed above.	
The final product of the work group will be a technical appendix that will: (1) describe the tools and metrics to be used for evaluation of water quality conditions; (2) the key locations in the basin at which the metrics will be measured; (3) the relationship and sensitivity of those metrics to operational changes associated with Treaty alternatives; (4) characterize water quality conditions under the reference operations(s); and, (6) describe the impacts	Water Quality Technical Appendix	30% Report—June 2012 60% Report—Oct 2012 90% Report—Jan 2013 Final Review—May 2013

of the alternatives.

Potential Resources:

Reference Material Available
STT Water Quality Work Shop Proceedings.
Inventory and Map of existing Columbia Basin WQ models
Preliminary Alternatives
Side Boards
Draft Evaluation Criteria and Metrics

Background & Reference Materials:

Background & Reference Material Available

Resources Available:

Resources Available

Treaty Review Preliminary Evaluation Criteria and Model Matrix

Primary Operational Driving Purposes				
Ecosystem-Based Functions				
1. Provide streamflows with appropriate timing, quantity and water quality in the basin to promote productive populations of native fish and wildlife. 2. Provide reservoir conditions to promote productive populations of fish and wildlife. 3. Provide for streamflow and reservoir conditions that protect and enhance cultural resources. 4. Improve hydrology in the estuary to promote productive populations of native fish and wildlife.				
Evaluation Criteria	Metric	Location(s)	Models	Data Needs (Also inputs needed)
Water Quality - Physical				
Temperature	Daily/seasonal change, unit accumulation	Border, Pend Oreille, Dworshak, lower Snake, Lake Roosevelt, mid-Columbia, lower Columbia, Flathead Lake, Libby and Hungry Horse reservoirs, Clark Fork, Kootenai and Flathead rivers.	CEQUAL-W2, LRMOD, HRMOD	
Total Dissolved Gas	Total Dissolved Gas	Border, Kootenai River, Flathead, lower Snake, Dworshak, mid-Columbia, lower Columbia, Clark Fork	CEQUAL-W2	Spill Discharge (cfs)
Turbidity	% Change (NTU)	Kootenai River, Lake Roosevelt, Lower Columbia and Estuary	CEQUAL-W2	
Sediment Concentration	mass of sediment per area	Estuary	DELFT 3D Hydrodynamic Model	Bathymetry, bed sediment grain size, daily mean discharge
Salinity	% Change PPT	Estuary	CMOP	Bonneville Outflow
Impact Assessment Areas				
Other Environmental Contamination Implications - Water Quality - Chemical				
<ul style="list-style-type: none"> Minimize the impact of contaminated sediments. 				
Evaluation Criteria	Metric	Location(s)	Models	Data Needs
Contaminants - water	amount of contaminant per sediments suspended; fish consumption	Lake Roosevelt	Colville model	reservoir elevation; discharge (velocity);
Contaminated Sediments	mass per unit volume or mass per mass	Mainstem		
Nutrient Effects (DO, pH, etc)				
Emerging Contaminants				
Contaminants - air	hazard index (amount of contaminant per sediments windblown; inhalation)	Lake Roosevelt; Libby		

Note: Seasonality Needs to be added to most metrics

Iteration #1 - Evaluation Metrics
Ecosystem Based Function

Location	Type of Objective	Metric	Seasonality	Benchmarks		Iteration #1 Metric	Display
				Lower	Upper		
Libby Dam	White Sturgeon Spawning and Recruitment	Tiered Flow Volume	April - August (Based on Volume Runoff Forecast)	0 - 1.6 MAF		✓	TG
	Spring Flow Management	14-Period Outflow	Jan – Apr 30	flood control curve		✓	G
	Refill for Summer Flow Augmentation	Reservoir Elevation	Early July	full pool 2459 feet		✓	
	Summer Draft	Reservoir Elevation	By Sept 30 to minimize second peak		2449 feet	✓	T
			Jun 30 – Sep 30: draft along straight line	draft along straight line			
	Bull Trout Operations	14-Period Outflow	May 15 – September 30	6000 cfs		✓	TG
			May 15 – 31	6000 cfs		✓	TG
	Montana State TDG Standard	TDG	Year round	Limit Spill so that 110% TDG is not exceeded		✓	T
Gauge on Kootenai River below Libby Dam	Resident Fish	14-Period Discharge	Year round	4000 cfs		✓	
			May 15 – Sept 30	6000 cfs		✓	
Hungry Horse	Improve Juvenile & Adult Fish Surival	Reservoir Elevation - Refill	June 30	full pool 3560 feet		✓	
		Reservoir Elevation - Draft	September 30	3550 feet		✓	
		Change in Reservoir Elevation	June 30 - September 30	draft along the straight line to minimize occurrences of a second			
	Summer Draft	Reservoir Elevation	By Sept 30 to minimize second peak		3550 feet	✓	T
			Jun 30 – Sep 30: draft along straight line	draft along straight line			
	Bull Trout Operations	14-Period Outflow	Year round	400 - 900 cfs		✓	
	Montana State TDG Standard	TDG	Year round	Maximum of 15% outflow for spill		✓	
Columbia Falls	Bull Trout Operations	14-Period Outflow	Year round	3200 - 3500 cfs		✓	
Albeni Falls	Kokanee Spawning	Reservoir Elevation	Winter	2053 feet		✓	
Grand Coulee Dam	Refill	Reservoir Elevation	April 10	URC		✓	
			June 30	1290 feet		✓	
			September 30	1283 feet		✓	
	Salmon Flow Objectives	Reservoir Elevation	August 31	1278 feet		✓	
	Washington State TDG Standard	TDG	Year round		115%	✓	
Vernita Bar	Flow Objective for Fall Chinook	14-Period Discharge	Dec – May	50,000 cfs		✓	
			Jun - Nov	36,000 cfs		✓	

Iteration #1 - Evaluation Metrics
Ecosystem Based Function

Location	Type of Objective	Metric	Seasonality	Benchmarks		Iteration #1 Metric	Display
				Lower	Upper		
Dworshak Dam	Improve Juvenile & Adult Fish Survival	Reservoir Elevation	April 3 - Aug 31		1535 feet	✓	
		Outflow Turbines			10 kcfs	✓	
		Outflow Spill			4 kcfs	✓	
		Reservoir Elevation	Sept 30		1520 feet		
	Idaho State TDG Standard	TDG	Year round		110 % TDG	✓	
Lower Snake River at Lower Granite	Seasonal Flow	14-Period Outflow	Spring: Apr 3 – Jun 20	85 kcfs	100 kcfs	✓	
			Summer: Jun 21 – Aug 31	50 kcfs	55 kcfs	✓	
	Washington State TDG Standard	TDG	April 1 - August 31		10 kcfs	✓	
Columbia River at McNary	Seasonal Flow	14-Period Outflow	Spring: Apr 10 - Jun 30	220 kcfs	260 kcfs	✓	
			Summer: Jul 1 – Aug 31	200 kcfs	200 kcfs	✓	
		TDG	April 1 - August 31		10 kcfs	✓	
Bonneville Dam	Seasonal Flow	14-Period Outflow	Year round	125 kcfs	160 kcfs	✓	
	Chum Habitat	Tailwater Elevation	Nov 1 - April 30	11.5 feet		✓	

Treaty Review
Preliminary Draft Iteration #1 Evaluation Criteria

Location or Control Point	Temperature			TDG	Turbidity % Change (NTU)	Sediment Concentration	Salinity % Change PPT
	Average Daily	Maximum Daily	Seasonal Change				
Canada - Columbia River							
Mica							
Arrow							
Duncan							
Brilliant							
Kootenay Lake							
Pend Oreille (Waneta)							
Canadian Border	x			x		x	
U.S. Upper Columbia							
Libby				x			
Bonniers Ferry							
Hungry Horse				xx			
Columbia Falls							
Kerr							
Thompson Falls							
Noxon Falls							
Cabinet Gorge							
Albeni Falls							
Grand Coulee	x	x		xxxx		x	
Chief Joseph				x			
U.S. Clearwater/Snake River							
Brownlee		x					
Dworshak							
Lower Granite		x					
Little Goose							
Lower Monumental							
Ice Harbor		x		x			
U.S. Mid-Columbia River							
Wells							
Rock Island							
Wanapum							
Priest Rapids		x		x			
Vernita Bar							
Richland/Kennwick							
U.S. Lower Columbia River							
McNary	x	xxxx		xxxx	x	xx	
John Day							
The Dalles				x			
Bonneville		x		x		xx	
Portland/Vancouver						x	
Estuaries		x					
US System							
Federal							
Mid-Cs							
Canadian							